## REMARKS/ARGUMENTS

Claims 1-39, 63-75, 77 and 81-84, withdrawn from consideration pursuant to Examiner's restriction requirement and Applicant's subsequent election, are cancelled by the foregoing amendment. Claims 40-62, 76, and 78-80, and new claims 85-87 are presented for examination.

## Amendments to the Claims

Claim 40 is amended to clarify the instant invention and redress Examiner's objections.

Primary Flow Direction: Applicant understands the examiner to interpret Claim 40 in light of Meenan such that the "streamwise curvilinear fluid flow direction" is in the peripheral direction through tubes 18A as shown by doted broad arrows. (i.e., such that: "the first direction being parallel to the central axis of the reactor (10) and the second direction being perpendicular to the central axis of the reactor 910)) mutually distinct from the streamwise flow direction,").

In contrast, the instant disclosure states:

> "[0453] Fluid flow direction--fluid flow directions "upstream" and "downstream" generally refer to the primary flow direction within the fluid duct 130. i.e., the general flow direction of the oxidant containing fluid 904 and of the energetic fluid 920."

E.g., along the direction from inlet 134 to outlet 136 in Fig. 1, Fig. 2, Fig. 4 and Fig. 14, Fig. 53, Fig. 66, and Fig. 67. Corresponding to this primary flow direction, the disclosure discusses non-uniform variations along the transverse direction transverse to the primary flow. E.g., with reference to Fig. 22, Fig. 23, Fig. 24, Fig. 25, Fig. 26, and Fig. 27 non-uniform distributions are shown from "Inner Radius" to "Outer Radius" for velocity, temperature, orifice diameter, and pressure. The peripheral direction along tube 10 in Fig. 5 is also described as a transverse direction in [0137]. In alternate configurations, the primary flow may come in radially as shown by flows 904 in Fig. 55 and Fig. 56.

To clarify the "primary" fluid flow direction, Claim 40 is modified to include a "reaction chamber", and the adjective "primary" is added to read in part (as amended):

> "configuring a reactor comprising a reaction chamber with an outlet; the reaction chamber having a streamwise curvilinear primary flow direction and a first and a second transverse direction mutually distinct and transverse to the primary flow direction, the first and second transverse directions defining a surface through a reaction chamber location;"

The change to "reaction chamber" is propagated through dependent claims 43, 45-50, 52, 55, 58-59, and 61. Dependent claim 47 was amended to add "primary" to clarify the streamwise flow direction.

To clarify the configuration, Claim 40 is amended by inserting "oxidizing" to modify "co-reactant" to read in part (as amended):

> "configuring a co-reactant delivery system and delivering a co-reactant fluid comprising an oxidizing co-reactant to the reaction chamber;"

This is supported in the specification, for example by

> "[0359] 904 Second Fluid, commonly a Fluid comprising a second reactant or an Oxidant, optionally comprising a thermal diluent fluid, herein also generically called an "Oxidant Fluid" and may comprise a "Humid Oxidant" (e.g., humid air or oxygen enriched air optionally mixed with steam or water, typically passing through a Fluid Duct across one or more perforated tubes, or else passing through an Oxidant Perforated Tube)", such as pressurized by and air compressor.

To clarify, claim 40 (as amended) reads in part:

> "wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, ..."

In instant disclosure teaches control of a reactor output variable within a parameter distribution range. e.g., [0684] teaches control of reactor pressure within surge boundaries, or temperature within a specified temperature range etc. The control method of claim 40 is further clarified to read in part (as amended):

> "greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

Claim 40 is further simplified to remove the logically inconsequential phrases "at least" and "or more of". Dependent claim 58 is similarly modified to remove "at least". These phrases are considered redundant in view of the claim employing the inclusive transitional phrase "comprising".

Claim 43 is amended to include the 10 Hz limitation of claim 44 as not being significantly different from "acoustically" in claim 43. Claim 44 is amended from 10 Hz to 100

Hz with the further constraint: "wherein reducing fluid pressure oscillation within the reaction chamber."

The methods of claim 45 and claim 46 are currently amended to refer to Claim 76 and to read "into the reaction chamber a frequency greater than 10 Hz, thereby reducing…".

The methods of claim 49 and claim 50 are currently amended from depending on Claim 40 to depend on claim 76.

In Claim 51, the order "diluent liquid" is inverted to "liquid diluent" to harmonize with the disclosure [0126], [0127], etc. Claim 51 is further amended to read in part:

> "wherein controlling the liquid spatial distribution to be non-uniform at a plurality of locations on the surface, the plurality of locations being taken along the first transverse direction."

e.g., as shown in [0805] and Fig. 24.

In claims 57 and 58, the clause "at least" is removed, also redundant in view of 'comprising'.

Claim 59 is amended to depend on claim 76, and from "reactor to "reaction chamber".

Claim 79 is amended to read, in part

> "controlling the spatial transverse distribution of the product fluid temperature at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

This provides further clarification over the transverse control of claim 40.

Dependent claim 80 is amended to depend on independent claim 76.

Dependent claims 85 and 86 are added subsidiary to claim 40

> "Claim 85 (Newly Presented)
>
> "The control method of Claim 40, wherein controlling one of the reactant and diluent transverse spatial distributions to be non-uniform at a plurality of locations on the surface, the spatial distribution being taken along the first transverse direction.".

Claim 76 has been amended to address examiners objections.

To distinguish from interpretations of the streamwise flow taken within manifolds or contactor tubes in the reactor periphery, Claim 76 is amended from "reactor" to "pressurized reactor comprising an upstream diffuser and a downstream reaction chamber in fluid communication," to read in part:

> "configuring a pressurized reactor comprising an upstream diffuser and a downstream reaction chamber in fluid communication, with a streamwise primary flow direction from a reactor inlet to outlet, and with a first and a second transverse direction mutually distinct and transverse to the primary flow direction;"

The Office Action, p. 6 (13) interprets Meenan as disclosing "wherein the co-reactant (gas) is diffused in the reactor (i.e., via jet openings of the tubular conduits (18)). The instant invention uses "diffusing" in the sense of a duct with changing cross sectional area causing a change in fluid pressure and velocity. i.e., the use common to turbomachinery of placing a "diffuser" between the compressor and the combustion chamber. E.g., as described in "Diffuser Design Technology" by David Japikse and Nicholas C. Baines, (1998) Concepts ETI, Inc. ISBN 0-933283-08-3.

In the disclosure, the diffuser 420 is schematically shown in Fig. 2 with multiple vanes 421. Embodiments are further exemplified in the perspective drawing of Fig. 14, Fig. 15, Fig. 16, Fig. 17, Fig. 18, Fig. 19, Fig. 20. The velocity profile transverse to an annular duct is shown in Fig. 22 for a single diffuser and for a multi-diffuser embodiment of the instant design. Upstream and downstream pressure and velocity transverse distributions are similarly shown in Fig. 27 for one embodiment. The diffuser method discussion includes [0500], and [0640]-[0660]. The disclosure refers to:

[0356] "901 First fluid, commonly comprising one or more of a First Reactant containing Fluid, or a Fuel containing Fluid, . . .", simplified in the claims to "reactant"; and

[0359] "904 Second Fluid, commonly a Fluid comprising a second Reactant or an Oxidant . . ." simplified in the claims to "co-reactant".

To distinguish the method of diffusing co-reactant through a diffuser in Claim 76 from the generic use of "diffusing" used in Office Action (13), Claim 76 is amended to indicate that the reactor is "pressurized" and comprises "a diffuser" and a "reaction chamber", to read in part:

"configuring a pressurized reactor comprising an upstream diffuser and a downstream reaction chamber in fluid communication,"

Claim 76 is further amended to read:

> "delivering a co-reactant fluid comprising the co-reactant into the primary upstream reaction chamber inlet with a spatial co-reactant distribution; the delivery comprising diffusing the co-reactant fluid into the reaction chamber through a plurality of co-reactant diffuser passages through a co-reactant delivery system;"

With the change from reactor, the spatial distribution control is clarified to read in part:

> "wherein controlling one of the spatial distribution of the co-reactant fluid and of the diluent fluid, the distribution being taken along the first transverse direction through a reactor location along the primary flow in one of the diffuser and the reaction chamber;"

To clarify the control provided, Claim 76 is amended to control "a prescribed spatial distribution" to read in part:

> "wherein controlling the transverse distribution of one of the composition, temperature, pressure, and velocity of the reaction product, to a prescribed spatial distribution, the transverse distribution being taken along the first transverse direction through a control location near the outlet of the reactor."

To further clarify the method of distributing reactant and diluent, dependent claims 86 and 86 are added subsidiary to Claim 76 to constrain a reactant or diluent distribution to be "non-uniform" to read:

"Claim 86 (Newly Presented)

The reaction method of Claim 76 wherein controlling one of the transverse reactant distribution and the transverse diluent distributions to be non-uniform, the spatial distribution being taken along the first transverse direction."

Claim 87 (Newly Presented)

The method of claim 76 wherein at least a portion of the diluent delivered by the diluent delivery system comprises one of liquid diluent, and is delivered as a liquid into the reactor; wherein controlling the liquid spatial distribution to be non-uniform at a plurality of locations on the surface, the plurality of locations being taken along the first transverse direction.

These amendments are fully supported in the original specification as filed, and no new matter has been added.

## Claim Objections

Examiner's indication of satisfactory amendments to claims 43, 47, 48 and 55 is gratefully acknowledged.

## Rejections Under 35 U.S.C. § 103

Claims 40-62, 76, and 78-80 are rejected under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 4,273,527 to Meenan ("Meenan") in view of U.S. Patent No. 4,483,137 to Faulkner ("Faulkner"). Applicant respectfully traverses the rejection.

Office Action page 3 (9) Claims 40, 76

Independent method claim 40 recites, in part (as amended)

> "... configuring a reactor comprising a reaction chamber with an outlet; the reaction chamber having a streamwise curvilinear primary flow direction and a first and a second transverse direction mutually distinct and transverse to the primary flow direction, the first and second transverse directions defining a surface through a reaction chamber location; ...
>
> "...wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:
>
> greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

Independent method claim 76 recites, in part (as amended)

> "...configuring a pressurized reactor comprising an upstream diffuser and a downstream reaction chamber in fluid communication, with a streamwise primary flow direction from a reactor inlet to outlet, and with a first and a second transverse direction mutually distinct and transverse to the primary flow direction;..."
>
> "... wherein controlling one of the spatial distribution of the co-reactant fluid and of the diluent fluid, the distribution being taken along the first transverse direction through a reactor location along the primary flow in one of the diffuser and the reaction chamber; and
>
> wherein controlling the transverse distribution of one of the composition, temperature, pressure, and velocity of the reaction product, to a prescribed spatial distribution, the transverse distribution being taken



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along the first transverse direction through a control location near the outlet of the reactor."

The Office Action alleges that the respective features in the previous claim version are taught by Meenan. Applicant respectfully submits that the features independent claims 40 or 76 are not taught by Meenan. The Office Action states at Para. 9 (p. 3) "the reactor (10) having a streamwise curvilinear fluid flow direction (see Meenan, Fig. 1) (showing a curved delivery path for delivery of reactants) and a first and a first [*sic*] and second transverse directions (see Meenan, Fig. 1) (e.g., the first direction being parallel to the central axis of the reactor (10) and the second direction being perpendicular to the central axis of the reactor 910)) mutually distinct from the streamwise flow direction . . .,"

The instant disclosure uses the adjective "curvilinear" [0436] to describe generic fluid ducts [0559] and coordinate systems [0437]. For the first transverse flow direction to be parallel to the central axis, the second flow to be perpendicular (or radial) to the central axis, and for the "first and a second transverse direction" to be "mutually distinct and transverse to the primary flow direction", the primary flow will be in the circumferential direction. See Office Action page 12 (28) regarding flow through the annular conduit 12.

Applicant understands the Office Action to identify the streamwise curvilinear flow direction to be along Meenan's broad arrows showing flow from manifolds through tubes 12A around the reactor periphery. In the instant disclosure, the reactor "streamwise curvilinear fluid flow direction" as taught in the instant disclosure includes the curvilinear direction of primary reactor flow within the "reaction chamber" (or "combustion chamber"), comprising co-reactant (or second) fluid flow, as well as reactant (or first) fluid, diluent (or third) fluid, and products of reaction (or combustion).

To clarify Claim 40, Applicant added "primary" to describe the streamwise flow, and added "reaction chamber" to distinguish the region comprising fluid delivery, and wherein the spatial reactant distribution the spatial diluent distribution and the respective flow directions are claimed.

Claims 40 and 76 include "first and second transverse directions mutually distinct from the streamwise flow direction, . . ." Consequently, "first and second transverse directions" have components transverse to the reactor streamwise primary flow direction and are not along it.

With reference to Meenan, Applicant respectfully submits that Meenan in Fig. 2 (as detailed in Fig. 1) shows a cylindrical "Top Hat" combustion chamber 28. The combustion chamber 28 is surrounded by a cylindrical refractory housing 46 with a closed end holding jets 42, 44 and 47 that axially deliver liquid fuel and/or pulverized fuel.

Air or oxidant fluid is introduced into chamber through peripheral tubular conduits 12 having radially inward jet openings 26. The gas and oxidant flows through orifices 26 and 30 are circumferentially constrained by the combustor refractory housing 46. Flows through orifices 26 and 30 are further axially constrained by the end wall. Consequently, the primary fluid flow (e.g., combined air, and gas, liquid fluid, or pulverized fuel, and combustion gas) exiting the combustor flows out through the open end of the "Top Hat" cylindrical combustor. i.e., axially along the direction parallel to the axis of the combustor chamber 28.

Upstream of the combustor outlet, by symmetry, cylindrical constraint and end constraint, the primary fluid flow near the axis is directed along the axial direction from the closed end towards the combustor outlet. (Displaced from the cylindrical reactor axis, secondary flows will be curvilinear beginning by the radial inflow through radial orifices 26 and 30 near the closed upstream end and tending towards the axial direction.) Referring to Meenan, the primary flow direction, as defined in amended Claim 40, cannot thus be along the circumferential direction as implied by the Office Action's identification of "the first direction being parallel to the central axis of the reactor (10) and second being perpendicular to the central axis of the reactor".

Referring to Meenan Fig. 1, Applicant identifies arrows or lines point to reactor 10, combustion chamber 28, gas and air orifices 26 and 30. Fig. 1 further shows fluid flow arrows from manifold 14 into perforated tubes 12A and fluid flow arrows from manifold 22 into perforated tubes 18B, etc. In Meenan Fig. 2, Applicant identifies a corresponding arrow to combustion chamber 28, orifices 47 and fluid arrow showing water flow out of tube 38. Applicant further sees the axial fluid flow arrows in liquid jets 42 and 44, and the axial fluid flow arrow for pulverized fuel in 47, with corresponding predominantly axial fluid flow lines out of those jets within the combustion chamber 28. In light of the clarification to amended Claim 40, respectfully, Applicant does not find any indication of Meenan teaching in Fig. 1 of "a curved delivery path for delivery of reactants" that results in "the first direction being parallel to the central axis of the reactor".

Meenan teaches both gas (reactant) and air (co-reactant) being directed radially into the combustor 28 through parallel orifices 26 and 30. Thus Meenan teaches peripheral reactant injection parallel to the co-oxidant injection, not transverse to it.

Similarly, the last line of the amended claim 40 reads "near the reactor outlet in at least one of the transverse directions." The reactor streamwise flow direction near the reactor outlet is generally parallel to the weighted mean flow "axis" of the reactor duct near the outlet, e.g., along the axis of the cylindrical reactor in Meenan. Consequently, both of "the transverse directions" "near the reactor outlet" are in principle NOT parallel to the reactor axis near the reactor outlet.

Consequently, Applicant respectfully submits that Meenan does not teach the features for which they are relied upon in the combination rejection of independent claim 40 or 76 as currently amended.

The Office Action states: "(d) controlling the spatial delivery of the reactant fluid (air) comprising reactant (air) into the reactor (10) in at least one of the transverse directions (e.g., by use of an air compressor) (see Meenan, column 2, lines 27-29);" The cited portion of Meenan makes no reference to a "pump" and only mentions "compressor" as follows:

"The supply tubes 14 and 16 are connected to a source of pressurized fluid such as an air compressor." Applicant's argument was (and remains) not merely that Meenan lacked *ipsiss verbis* teaching of the words used in the instant claims, but rather that is lacked any language that would support the assertion that Meenan teaches what is attributed to it, i.e., controlling spatial delivery of the relevant fluid.

Thus, while Meenan mentions a compressor and delivery of pressurized fluid, the reference makes no mention of controlling or varying that pressure, as recited in the instant independent claims.

The Office Action (page 4) following (e) cites:

". . . And wherein controlling the at least one spatial distribution of the reactant fluid (air) (e.g., by use of an air compressor) (see Meenan, column 2, lines 27-29) in at least one of the transverse directions controls the transverse distribution of at least one of the composition, temperature, pressure, and streamwise velocity of the product fluid, near the reactor in at least one of the transverse directions (see Meenan, entire disclosure.)"

To clarify control of the transverse distribution of parameters near the reactor outlet, claim 40 is amended to read:



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"...wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:

greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

The instant invention describes controlling transverse temperature profiles (e.g. [1746]), including at multiple transverse locations near the combustor exit or outlet (e.g. [1747]) etc. It discloses controlling transverse distributions or profiles of parameters within ranges. E.g., flow ratio [0457], temperature [0462] etc.

Meenan teaches a uniform "Top Hat" configuration of peripherally configured uniformly spaced orifices with uniform radial orientation and uniform orifice size with reactant (gas) orifices parallel to co-reactant (air) orifices. Meenan provides for one axial pulverized coal fuel end jet 47 or two end jets 42 parallel to the axis for fuel oil. Meenan only refers to a temperature, not to a temperature profile or plurality of temperatures, nor to "control". E.g.,

"The outlet 38 may be connected to an inlet of a boiler of a furnace or a similar device that utilizes fluid at a high temperature." Meenan, Col. 3, lines 2-4;

"The system 10 operates by firing of the combustion chamber 28 and feeding the chamber with fuel from the nozzles 42 and 44 to create a high temperature that results in proper combustion of the pulverized fuel introduced by the nozzle 40." Meenan, Col. 3, lines 26-30

Respectfully, Applicant submits that Meenan does not teach either method of how to control either the spatial transverse distribution of reactant fluid, nor of the diluent fluid, per amended Claim 40:

"...wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction..."

Furthermore, Applicant holds that Meenan does not teach the method of how controlling each of those reactant and diluent fluids:

"controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:

greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

Accordingly, applicant submits that Meenan does not teach or suggest the features for which it is relied upon in relation to the features of amended claim 40 or claim 76, including to obtain the non-uniform distributions transverse to the flow.

Furthermore, the Office Action (page 4, para 2; page 5, para 1) observes that Meenan does not disclosure "wherein the reaction occurs in the presence of diluent", nor of controlling that diluent by steps (i), (ii), (iii), and (iv).

The Office Action posits that one with ordinary skill in the art may combine the diluent addition system of Faulkner with the reactor of Meenan. Faulkner in Fig. 2, Fig. 8 and Fig. 4 shows some 21 air blast fuel injectors configured near the upstream end of an annular combustor. The injectors appear radially located about midway across the annulus. Faulkner in Fig. 2 shows use of upper and lower manifolds 110 and 112 with check valves 126 and 130 to halve the pressure difference between upper and lower nozzles 114.

Faulkner teaches: "water can be introduced into combustor 32 by way of the assist air passage 184 and primary air passage 186 in fuel injection nozzles 114 to reduce the nitrogen oxides emitted by engine 10." Faulkner expects that: "The swirling primary combustion air, along with that discharged from swirl vanes 174, atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." "This promotes uniform mixing of the water and fuel and, as a result, a uniform distribution of the water in the combustor's primary combustion zone." Faulkner further expects "that an even and uniform distribution of the water is obtained", and that "efficient atomization and uniform mixing of the water, fuel, and combustion air is obtained even at low water to fuel flow ratios."

Other than asserting "uniform mixing" and "even and uniform distribution of the water" with an annular configuration of air blast nozzles, Faulkner does not appear to teach how to actually configure the fuel or water delivery or how to control the transverse distribution of either fuel or water. Faulkner gives an embodiment in which "0.052 inch diameter orifices were employed." Other than uniform orifice sizes and the drawing showing uniform annular nozzle spacing, Faulkner gives no teaching on varying orifice size nor spacing nor angle to control transverse distributions of reactant or diluent.

As shown in Table 1, Faulkner reports only a single parameter for temperature, NOx emissions, and water/fuel ratio for a given operating condition. Faulkner describes: "at a constant power turbine inlet temperature". Faulkner does not appear to address the radial or "profile"

variations in air flow, fuel flow, air/fuel ratio, pressure, velocity, temperature, fuel evaporation, water evaporation, or NOx emissions across the annular combustor transverse to the reactor streamwise flow.

Nor does Faulkner appear to address the substantial circumferential or "pattern" variation in the corresponding air flow, fuel flow, air/fuel ratio, pressure, velocity, temperature, fuel evaporation, water evaporation, or NOx emissions around the annular combustor transverse to the reactor streamwise flow due to the relatively small number of nozzles.

Furthermore, other than using a modest number of typical airblast nozzles with swirl, Faulkner does not appear to configure the delivery distribution of reactant, co-reactant or diluent (e.g., air, fuel, and liquid water) to address the variations in these radial and/or circumferential distributions transverse to the reactor streamline flow.

The benefit of water in cooling flame temperatures and NOx was well known. Faulkner's reported NOx emissions in Table 1 of 30 ppm at full load appear to be an order of magnitude higher than what might be achievable with the improved mixing of air, fuel, and water as taught by the present disclosure.

Applicant respectfully submits that Faulkner teaches neither the method of how to control the spatial transverse distribution of reactant fluid, nor of controlling the spatial transverse distribution of the diluent fluid, nor of both, per amended Claim 40:

> "...wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction..."

Furthermore, Applicant holds that Faulkner does not teach the method of how controlling each of those reactant and diluent fluids wherein controlling:

> "a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid,"

In addition, Applicant holds that Faulkner does not teach controlling at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:

> "greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

With respect, Applicant does not find that Faulkner teaches the methods of controlling spatial or temporal distributions of reactant, co-reactant, or diluent so as to control any of the transverse distributions cited in the claims, as shown in the applicant's disclosure. Thus, neither

Meenan nor Faulkner teaching now to control such spatial or temporal distributions. Even presuming that there were some apparent reason to combine the references as proposed in the Office Action, Applicant respectfully submits that one skilled in the art would not take the diluent delivery system of Faulkner in the method/reactor of Meenan to achieve the methods claimed in Claims 40 or 76. It is well settled by the courts that to establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

Claims 41-42, 45, 51-58 and 61-62 each depend, either directly or indirectly, from independent claim 40. Claims 46, 49, and 50 depend either directly or indirectly, from independent claim 76. These dependent claims are each separately patentable, but they are offered as patentable for at least the same reasons at their underlying independent base claim, the features of which are incorporated by reference.

**Office Action page 6 (10) Claims 41 and 42**

Respecting claims 41 and 42, on page 6 #(10), the Office Action observes "Faulkner discloses wherein the diluent fluid comprises water", and "wherein the diluent is added to control the reaction temperature". As described above, Faulkner does not describe the methods taught in Claim 40, and thus does not teach the method of Claim 41 wherein the diluent fluid comprises water. Regarding claim 42, Faulkner describes control "at a constant power turbine inlet temperature". However, Faulkner does not describe controlling or measuring a plurality of temperatures at plurality of locations transverse to the reactor outlet, nor for measuring a transverse distribution of temperature. Faulkner does not refer to either "average temperature" nor to "mean temperature." Nor "enthalpy", nor "heat of reaction" or "heat of combustion". Accordingly, Faulkner does not teach:

"controlling the mean outlet temperature of the product fluid exiting the reactor by controlling the amount of diluent delivered through the diluent delivery system to control the total enthalpy change relative to the heat of reaction and the fluid delivery temperatures."

**Office Action page 6 (11) Claim 45**

Claim 45 as Currently Amended recites:

> "The method of claim 76 further including modulating the spatial delivery of the reactant fluid into the reaction chamber a frequency greater than 10 Hz, wherein reducing fluid pressure oscillation within the reaction chamber."



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Claim 76 has been clarified to incorporate a "diffuser" for diffusing co-reactant which is described in the disclosure as commonly second fluid or oxidant fluid. E.g., commonly air. The reactant fluid is described in the disclosure as "first fluid". E.g. this is commonly fuel, not air, and is modulated by the fuel delivery system, not by modulating the air compressor.

Meenan makes no mention of "modulating", or "varying", nor "controlling", nor "dynamically", nor "oscillations" or "Hz". Meenan's only mention to "pressure", is the generic observation that this: "combination gas and oil assisted pulverized fuel burning system generally designated by the reference numeral 10 that may be employed in conjunction with a high or low pressure furnace . . ."

Office action page 13 (29) suggests that manually turning the compressor "on" or "off" constitutes "modulating a spatial delivery of reactant fluid into the reactor." As amended claim 45 requires a frequency "greater than 10 Hz" which is faster than can be done manually.

While Meenan includes a compressor, applicant respectfully submits that Meenan does not teach or suggest: "modulating the spatial delivery of the reactant fluid into the reactor to reduce fluid pressure oscillation within the reactor" per claim 45. Faulkner does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Meenan relative to claim 45. Therefore, Applicant respectfully submits that claim 45 as amended is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 6 (12) Claim 46**

With reference to claim 46, this claim is amended to depend on Claim 76. It recites "modulating the spatial delivery of the diluent fluid into the reaction chamber a frequency greater than 10 Hz, wherein reducing fluid pressure oscillation within the reaction chamber."

Faulkner addresses: "The height difference between the air assist and coolant lines or pigtails leading to the upper and lower fuel injection nozzles produces a considerable difference between the pressure on the coolant flowing to the upper and lower nozzles." It teaches: ". . . this problem can be solved by installing orifices and/or the use of a manifold system of the type shown in FIG. 2 in the pig tails. These reduce the difference in coolant flow to the upper and lower injection nozzles by increasing the coolant inlet pressure because mass flow is proportional to .DELTA.P/P ", etc. Consequently: "As long as the engine is running and fuel is being supplied to it through fuel lines 120 and 122, the pressure in line 122 is higher than that in lower manifold 112 by virtue of the pressure drop across check valve 126".

Acoustic pressure oscillation is heightened by delivery from point sources, such as used by Faulkner. The distributed delivery methods taught in the instant invention substantially reduce the propensity to acoustic modulation. The instant dynamic spatial control provides further reduction of the pressure oscillations. Furthermore, Faulkner does not mention rapid dynamic or acoustic control greater than 10 Hz. Faulkner makes no mention of "modulating", nor "dynamically", nor "oscillation", nor "noise" nor "Hz", (nor "acoustic", nor "rumble", "growl", nor "hum", nor "whistle", nor "vibration".)

With respect, Applicant submits that Faulkner does not teach or suggest: ". . . further including modulating the spatial delivery of the diluent fluid into the reactor at a frequency greater than 10 Hz, wherein reducing fluid pressure oscillation within the reaction chamber." per amended Claim 46. Furthermore, Meenan does not offer, nor is it alleged to give, any teaching or suggestion of rapid, dynamic, or acoustic control greater than 10 Hz that would ameliorate the deficiencies of Faulkner relative to amended claim 46. Therefore, Applicant respectfully submits that amended claim 46 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office action page 6 (#12) re Claim 78**

Claim 78 recites "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of the co-reactant fluid delivery system."

Faulkner's only reference to "control" is to air flow through the compressor: "Engine 10 includes a fifteen-stage axial flow compressor 12 with a radial-axial inlet 14. Inlet guide vanes 16 and stators 18 of the compressor are supported from compressor housing 20 with the guide vanes and the stators 18-1 through 18-5 of the first five stages being pivotally mounted so that they can be adjusted to control the flow of air through the compressor." It mentions reducing pressure difference of coolant delivery "by installing orifices and/or the use of a manifold system of the type shown in FIG. 2 in the pig tails."

Faulkner makes no mention of (compressor) "surge" or "choke". Faulkner does not mention or document the change in combustor pressure with load, in Tables 1-6.

With respect, Applicant holds that Faulkner does not teach or suggest Claim 78. Nor does he teach the method of claim 79 with the constraints of Claims 78 and 40

Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 78. Therefore, Applicant respectfully submits that claim 78 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 6 #13: re claim 49-50.**

Claims 49 and claim 50 are amended to depend on Claim 76 which is amended where the reactor comprises a diffuser upstream of a reaction chamber by which the co-reactant is diffused into the reaction chamber.

**Office Action page 6 #13: re claim 49:**

Meenan does not disclose a diffuser upstream of the reaction chamber in the meaning used in turbomachinery as taught within the disclosure. The Office Action objects: "(2) wherein the diluent is evaporated (see Faulkner, column 1, lines 40-46)." Faulkner makes no mention of "vapor". Faulkner states: "This reduces the flame temperature by evaporation of the coolant and because the coolant raises the average specific heat of the combustion mixture."

However, claim 49 prescribes: "delivering the diluent as one of diluent vapor and steam". i.e., delivering a gaseous fluid as distinct from Faulkner's description of delivering a liquid that then evaporates. E.g., the instant disclosure includes:

[0497] "The mixing zone 422 may include multiple distributed contactors 10 configured in one or more direct contactor tube arrays 260. These tube arrays may be positioned in multiple locations, such as upstream near the outlet of the diffuser, as well as further downstream. They may be configured to deliver one or both of a vapor diluent containing fluid such as steam, and a liquid diluent containing fluid such as water.. . .." "[0665] Users often desire to deliver an evaporated liquid as diluent, and preferably a superheated vapor. . . ."

**Office Action page 6 #13: re claim 50.**

As noted for claim 49, the Office action's objection that "Meenan discloses wherein the co-reactant (gas) is diffused in the reactor" is obviated by Claim 50 comprising "configuring a diffuser" in the meaning of turbomachinery as taught in the instant disclosure. The Office Action states Faulkner as "wherein the diluent is delivered as liquid water (see Faulkner, column 2, lines 5-9; column 9, lines 42-60; and entire disclosure)." Faulkner configures: "The high pressure air discharged from compressor 12 flows through an annular, diverging diffuser 28 into an enlarged plenum 30 and from the latter to an annular combustor 32 housed in a case 34." (Col 5: 1-4). Faulkner teaches delivery of liquid diluent (water) with reactant (fuel) in the combustor (32)

downstream of the plenum (30). By contrast, Claim 50 specifies ". . . delivering a portion of the diluent as liquid near the diffuser outlet."

Therefore, Applicant respectfully submits that claim 49 and claim 50 are further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 6 #13: re claim 51.**

The Office Action acknowledges: "Meenan does not disclose wherein the reaction occurs in the presence of diluent". As described above, Faulkner does not teach the method of independent Claim 40, and thus does not teach that method with liquid diluent or liquid water.

**Office Action page 6 #13: re claim 52.**

As described above for claim 49, Faulkner makes no mention of delivering "steam" or "vapor". The Office Action further acknowledges: "Meenan does not disclose wherein the reaction occurs in the presence of diluent . . ." Accordingly, neither Faulkner nor Meenan teach:

"wherein at least a portion of the liquid diluent is delivered to the reaction chamber streamwise downstream of the vapor diluent delivery" per Claim 52.

**Office Action page 6 #14 re Claim 53.**

Claim 53 is amended from depending on Claim 40 to depend on Claim 76 to prescribe co-reactant being diffused in the reactor through an upstream diffuser. E.g., such as an oxidant fluid or air being compressed and delivered through the diffuser in turbomachinery. Claim 53 recites "reactant delivery system and the diluent delivery system are configured to form interspersed reactable and non-reactable regions and further comprising providing a traversing region of reactable fluid traversing at least one of the non-reactable regions from one reactable region to another." Herein, reactant or first fluid is typically fuel in combustion system. See [0356]. Thus the "reactable" vs "non-reactable regions" are distinguished by fluids delivered by the "reactant delivery system and the diluent delivery system".

Meenan does not teach delivering diluent (e.g., water, steam or CO2) into the combustor. Meenan only shows delivery of reactant and co-reactant (air and gas, liquid fuel and/or pulverized fuel). Thus, Meenan does not form "non-reactable regions" by the relative delivery of reactant (e.g. fuel) and diluent (e.g., water) as defined by claim 53. Furthermore, Meenan teaches: "In addition, the combustion process is maintained throughout the length of the combustion chamber 28 by the introduction of the air by the first set of conduits 12 and gas by the second set of conduits 18 extending along the full length of the combustion chamber 28."

Thus Meenan appears to teach combustion methods that are explicitly "maintained" between air conduits 12 and gas conduits 18 "along the full length of the combustion chamber 28." This excludes formation of "non-reactable regions".

With respect therefore, Applicant submits that Meenan does not teach formation of "reactable vs non-reactable regions" due to configurations of reactant and diluent delivery. Accordingly, Meenan does not teach or suggest: "the reactant delivery system and the diluent delivery system are configured to form interspersed reactable and non-reactable regions and further comprising providing a traversing region of reactable fluid traversing at least one of the non-reactable regions from one reactable region to another" per claim 53. Faulkner does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Meenan relative to claim 53. Therefore, Applicant respectfully submits that claim 53 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (17) Claim 56**

Claim 56 recites "at least a portion of the diluent is delivered streamwise downstream of a rapid reaction front." As shown in Fig. 6, Faulkner discloses: "The swirling primary combustion air, along with that discharged from swirl vanes 174, atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." The combustion or reaction front is downstream of this delivery location.

The Office Action asserts "Faulkner is not particularly limited with respect to the exact location within the reactor/combustion chamber the diluent is to be delivered." With respect, Faulkner only teaches delivering water and fuel together through the compound air blast nozzle 114 shown in Fig. 5 and located as shown in Fig. 3. In Tables 1-6, Faulkner gives examples of water/fuel ratios of 0 to 1.88. Faulkner does not teach or suggest delivering diluent (water or CO2) downstream of the combustion or reaction front. Nor does Faulkner refer to "quench" or "thermal quench limit" or how to overcome that limit. Accordingly, Faulkner does not teach: "wherein at least a portion of the diluent is delivered streamwise downstream of a rapid reaction front" of claim 56. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 56. Therefore, Applicant respectfully submits that claim 56 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (17) Claim 57**

Claim 57 recites "controlling the evaporation of a vaporizable portion of diluent by controlling a streamwise flow direction velocity distribution of the diluent as delivered from the diluent delivery system evaluated along at least a first transverse direction." The Office Action states "the amount of diluent to be delivered could be changed based on the desired temperature and/or NOx emission levels". However, Faulkner's only reference to evaporation is: "This is the approach I employ to reduce the NOx emissions of gas turbine engines. I do this by introducing a liquid coolant into the primary combustion zone of the turbine engine combustor. This reduces the flame temperature by evaporation of the coolant and because the coolant raises the average specific heat of the combustion mixture." Faulkner's only mention of "velocity" is to the air velocity: "This thin film of liquid fuel is contacted, and atomized, by the high velocity, swirling, primary combustion air . . ." and "dumped into the forward part of plenum 30, decreasing the flow velocity of the air. . . ." Faulkner apparently makes no mention of controlling the streamwise velocity of the diluent, nor of controlling the transverse distribution of streamwise velocity.

Applicant respectfully submits that Faulkner does not teach or suggest: ". . .controlling the evaporation of a vaporizable portion of diluent by controlling a streamwise flow direction velocity distribution of the diluent as delivered from the diluent delivery system evaluated along at least a first transverse direction" per Claim 57. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 57. Therefore, Applicant respectfully submits that claim 57 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (17) Claim 58**

Claim 58 recites "controlling the streamwise evaporation distance of the diluent in the reactor with respect to at least one of the transverse directions." Further to discussion of Claim 57, above, Faulkner makes no mention of "streamwise" nor of "distance" nor of "transverse" nor of how to control an "evaporation distance". Applicant respectfully submits that Faulkner does not teach: ". . .controlling the streamwise evaporation distance of the diluent in the reactor with respect to at least one of the transverse directions." Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 58. Therefore, Applicant respectfully submits that claim 58 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (18) Claim 61**

Claim 61 recites "providing at least a portion of the reactor with coolant passages, cooling at least a portion of the reactor with diluent, and delivering at least a portion of the heated diluent to the reactor." As noted above, with respect, Applicant does not find that either Meenan or Faulkner teach the methods of controlling spatial or temporal distributions of reactant, co-reactant, or diluent so as to control any of the transverse distributions cited in Claim 40. Neither mention delivering heated water into the reactor/combustor. Applicant respectfully submits that one skilled in the art could not take the water delivery system of Faulkner with Meenan method of heating water, to achieve transverse distributions of claim 40 together with the diluent heating and delivery of claim 61. Therefore, Applicant respectfully submits that claim 61 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (19) Claim 62**

Claim 62 recites "controlling the temperature of the product fluid exiting the reactor by controlling the total diluent enthalpy change comprising vaporizable diluent being delivered to the reactor" combined with the control of transverse distribution of Claim 40. By comparison, Faulkner teaches:

> "The efficacy of my novel technique for reducing the nitrogen oxides generated in a combustion process was demonstrated by tests in which a gas turbine engine of the type discussed above and identified by reference character 10 in the drawings was run as discussed above at a constant power turbine inlet temperature and over the range of operating conditions varying from no-load to full load and at a still higher load level (1935.degree. TRIT) that might be encountered under standby applications of the engine, for example. The water to fuel mass flow ratios employed at the various load conditions and the reductions in NOx emissions that were obtained are tabulated along with related, relevant data in the following tables:"

From the tables of data Faulkner provides, it appears that he selects a nominal load level resulting in a nominal power turbine inlet temperature. For example, in Table 1, at nominal "Full Load", the Power Turbine inlet Temperature is about 1256 °F, with power of 8936 BHP based on the air/fuel ratio at 0 Water/Fuel. Then Faulkner increments the water/fuel and appears to adjust the fuel to maintain the power turbine inlet temperature, e.g., to 1.60 Water/Fuel, with a power increase of 21.7% to 10872 BHP while keeping the power turbine inlet temperature at 1256°F. The burner efficiency only increases 0.5% from 99.45% to 99.95%. This can only be

accomplished by a major increase in fuel delivery, e.g., by 21.1% more fuel (assuming the turbine efficiency remained the same).

In its examples Faulkner sets the water/fuel ratio and then adjusts the fuel to obtain the same temperature at the power turbine inlet temperature. Furthermore, the cooling effect of water is higher than that of air, and the pumping work to deliver water is much lower than that to deliver air. Consequently, Faulkner's method of controlling the Power Turbine Inlet Temperature with varying Water/Fuel ratios does NOT equate to controlling the temperature at the outlet of the combustor (or the inlet to the compressor turbine inlet temperature). Faulkner's combustor outlet temperature would be expected to vary with water/fuel ratio even when he keeps the Power Turbine Inlet Temperature the same per Faulkner's examples.

Faulkner's reference to constant "power turbine inlet temperature" does not teach how to control the mean compressor turbine inlet temperature, e.g., with respect to variations in air/fuel ratio and/or water/fuel ratio, nor how to control the transverse distribution of fluid delivery nor the transverse distributions of these ratios. Faulkner mentions one TRIT without definition. It apparently gives no indication whether this is a single temperature measurement, or a mean, mode or peak temperature. Faulkner apparently makes no mention of the transverse distribution near the combustor outlet of any of "the composition, temperature, pressure and velocity of the reaction product". Nor does Faulkner teach how to control the fluid spatial delivery to control those outlet transverse distributions.

Faulkner asserts without measurement or modeling that his invention: ". . .atomizes the water, as well as the liquid fuel, forming a homogeneous mixture of the two liquids." It asserts: "that an even and uniform distribution of the water is obtained" and "that efficient atomization and uniform mixing of the water, fuel, and combustion air is obtained even at low water to fuel flow ratios". All this without any documentation of measurement of either the transverse distribution of the air flow or the water flow. These assertions are not supported by numerous reports in the literature of substantial variations in the transverse distribution of air flow, fuel distribution and temperature across the combustor.

With respect, Faulkner does not teach the claimed methods of using diluent (e.g., water) delivery to control the combustor outlet temperature while adjusting fuel delivery to control the power. Consequently, Faulkner does not teach ". . . controlling the temperature of the product fluid exiting the reactor by controlling the total diluent enthalpy change comprising vaporizable

diluent being delivered to the reactor" per claim 62. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 62. Therefore, Applicant respectfully submits that claim 62 is further distinguished over Meenan and Faulkner, taken singly or in combination.

**Office Action page 7 (19) Claim 79, 80**

Claims 79 and 80 both depend from claim 78, and incorporate the features of their underling base claim by reference. The Office Action does not allege that Meenan and Faulkner, even in combination, teaches or suggests the features of claim 78. Therefore, Applicant respectfully submits that the Office Action has not made a *prima facie* case of obviousness as to claims 79 and 80.

Notwithstanding, Claim 79 as currently amended recites:

"controlling the spatial transverse distribution of the product fluid temperature at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

Faulkner teaches: "This reduces the flame temperature in the combustor, thereby discouraging the formation of thermal NOx." "This is the approach I employ to reduce the NOx emissions of gas turbine engines. I do this by introducing a liquid coolant into the primary combustion zone of the turbine engine combustor. This reduces the flame temperature by evaporation of the coolant and because the coolant raises the average specific heat of the combustion mixture." ". . . the novel manifold system used to supply liquid fuel to the fuel injection nozzles of the gas turbine engines in which NOx emissions are reduced in accord with the principles of the present invention." "Primary among these is that introduction of the fuel in that manner enhances the efficiency of the coolant used to suppress thermal NOx formation." ". . . be equipped with a water injection system embodying the principles of the present invention to reduce the emission of nitrogen oxides from the engine." "I pointed out above that water can be introduced into combustor 32 by way of the assist air passage 184 and primary air passage 186 in fuel injection nozzles 114 to reduce the nitrogen oxides emitted by engine 10." "Specifically, my invention is readily adaptable to a wide range of air blast fuel injection nozzles and, generally, to the reduction of NOx emissions in other settings, not just those involving gas turbine engines."

Faulkner's only reference to "control" or "adjust" is: "with the guide vanes and the stators 18-1 through 18-5 of the first five stages being pivotally mounted so that they can be adjusted to control the flow of air through the compressor." Furthermore, Faulkner does not use "maintain". Its only references to "limit" are regarding NOx, e.g. "One primary object of the present invention is to provide novel, improved gas turbine engines which are capable of meeting the limitations on NOx emissions imposed by existing and proposed legislation."

As noted above with respect to Claim 62, Faulkner's example is to set the water/fuel and adjust the fuel delivery to control the power turbine inlet temperature. Faulkner's only reference to air pressure is: "By increasing the size of the opening, the pressure on the atomization assist air required for good atomization of the fuel during light-off can be significantly reduced."

With respect, Faulkner does not teach controlling the pressure per Claim 78, nor does he teach "comprising controlling the temperature of the product fluid" per claim 79. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 79. Therefore, Applicant respectfully submits that claim 79 is further distinguished over Meenan and Faulkner, taken singly or in combination.

Claim 80 recites "controlling the spatial distributions of the delivery of diluent fluid and of reactant fluid to the reactor wherein controlling the spatial distribution of pressure within the reactor in at least one of the transverse directions to within the at least one specified safe operating bound, and controlling the distribution of temperature of the product fluid in at least one of the transverse directions."

As noted above with respect to claim 79, Faulkner does not teach how to control the pressure nor does he teach how to control the temperature of the product fluid. Consequently, Faulkner does not teach how to controlling the spatial distribution of reactant or diluent, nor how to control the transverse distributions of pressure or of temperature of the product fluid per Claim 80. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Faulkner relative to claim 80. Therefore, Applicant respectfully submits that claim 80 is further distinguished over Meenan and Faulkner, taken singly or in combination.

In light of the foregoing, Applicant respectfully submits that the rejection of claims 40-42,45,46 49-58, 61, 62, 76, and 78-80 has been obviated, and kindly requests favorable reconsideration and withdrawal thereof.

**Office Action page 8 (20) Claims 43, 44, 46 and 78**

Claims 43, 44, 46 and 78 are rejected under 35 U.S.C. § 103(a) as being obvious over Meenan in view of Faulkner and U.S. Patent No. 5,349,811 to Stickler ("Stickler"). Applicant respectfully traverses the rejection.

**Office Action page 8 (21) Claim 43 and Claim 44**

Amended Claim 43 recites "acoustically modulating the delivery of at least one of the delivered fluids thereby acoustically modulating the reacting fluid within the reaction chamber with a frequency greater than 10 Hz."

Claim 44, as currently amended, recites "The method of claim 43 further including modulating the delivery of one of liquid fluid to at least 100 Hz, wherein reducing fluid pressure oscillation within the reaction chamber.

The Office Action posits Stickler as teaching the features of the previous claims 43, 44. .

Stickler observes: "The liquid fuel is introduced through nozzles or fuel injectors in the form of a fine spray. The air is compressed and introduced to the combustion chamber through a multiplicity of discrete jets and cooling passages. A minor amount of the air passes through the fuel nozzle to assist spray formation and distribution. A further amount of the air is introduced to mix with this spray as primary air to form an initial combustible mixture with the fuel."

Stickler teaches "the introduction of an externally modulated, rapidly pulsed, oscillated or sinusoidal fuel flow delivery rate" such that the "primary effect of such mixing is rapid mixing of regions of hot combustion gases with cooler, typically higher oxygen content gases," "to constrain the extent of NOx formation, while allowing complete oxidation of the combustion gases."

In particular, Stickler teaches control "resulting in a controlled degree of gas flow oscillation within the combustor which. can be excited and driven to finite absolute amplitude using a relatively minor amplitude of fuel flow pulsation modulation," Stickler thus explicitly amplifies oscillations within the reaction chamber to increase mixing. Stickler's teaching is directly opposite the instant Claim 44, as currently modified, "wherein reducing fluid pressure oscillation within the reaction chamber."

Aside from mentioning a plurality of nozzles 11 forming fine sprays. Stickler does not appear to teach how to control the spatial delivery of fuel or air to achieve a desired transverse distribution of fuel or air/fuel ratio. Stickler makes no mention of "transverse", nor "spatial".



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Furthermore Stickler does not teach delivery of diluent, nor spatially controlling such diluent. Stickler discounts water delivery for NOx control as: "expensive in terms of capital equipment for ensuring adequately clean water delivery, and in system efficiency loss due to water vaporization, It is not attractive for aircraft applications."

Thus, while affecting the local mixing and local temperature, and reducing NOx, Stickler does not appear to teach the method of Claim 40 as currently amended:

> "wherein controlling the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:
>
> greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations."

As observed above with respect to claims 40 and 76, neither Meenan nor Faulkner teach such transverse control.

Applicant respectfully submits that a person of ordinary skill in the art would not be able to take the method/reactor of Meenan with the diluent addition system of Faulkner with the fuel delivery method of Stickler to configure a system conforming to Claim 40. Applying Stickler's pulsed fuel injection oscillation enhancement method does not thereby overcome the inadequacies of Meenan, and Faulkner to perform Claim 40 with the oscillation reduction fluid modulation method of Claim 43 and Claim 44.

**Office Action page 8 (22) Claim 46**

Claim 46 (as amended) recites "modulating the spatial delivery of the diluent fluid into the reactor at a frequency greater than 10 Hz, wherein reducing fluid pressure oscillation within the reaction chamber."

The Office Action posits that "Stickler discloses wherein the reactor pressure can be controlled by adjusting the delivery of reactant fluid to the reactor." Stickler's method enhances combustor pressure oscillations to increase mixing in view of Meenan and Faulkner to reduce NOx. Neither Claim 76 nor claim 46 address reducing NOx.

With respect, Stickler teaches modulating fuel to increase pressure oscillation to improve mixing and reduce NOx. e.g., "can be employed to drive combustor pressure and flow oscillations", etc. In particular Stickler teaches how: "such factors are ideally chosen to result in

air jet flow velocity approximately out of phase with the fuel flow, . . .amplifying the effect of the fuel flow perturbation on the primary zone stoichiometry, its temperature, and consequently on the combustor pressure and flow oscillation,"

However, pressure oscillations in gas turbine combustors cause fatigue and have been known to cause the combustor to break free and destroy the downstream expander. Industry has worked strenuously to reduce such pressure oscillations.

Stickler's teaches methods to pulse fuel delivery to increase or maximize combustor pressure oscillations, not reduce them. Stickler in light of Faulkner does not teach how to modulate diluent to reduce pressure oscillations, nor how to control the spatial transverse temperature distribution. Accordingly Stickler in light of Faulkner does not teach: "modulating the spatial delivery of the diluent fluid into the reactor to reduce fluid pressure oscillation within the reactor" per claim 46. Meenan does not offer, nor is it alleged to, any teaching or suggestion to ameliorate the deficiencies of Stickler and Faulkner relative to claim 46. Therefore, Applicant respectfully submits that claim 46 is further distinguished over Meenan, Faulkner and Stickler, taken singly or in any combination.

**Office Action page 8 (20) Claim 78**

Claim 78 prescribes "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of the co-reactant fluid delivery system." The Office Action posits that "Stickler discloses wherein the reactor pressure can be controlled by adjusting the delivery of reactant fluid to the reactor."

Stickler teaches modulating (pulsing) fuel to increase pressure oscillations to increase mixing. Stickler's Abstract and Col 9 and 10 address increasing pressure oscillation without net pressure gain. However, increasing pressure oscillation is believed to actually degrade compressor performance and surge breakdown near the compressor safety bounds.

By contrast, the instant specification discloses *inter alia*, control of diluent fluid and reactant fluid, to control of pressure and temperature within the reactor to stay within safe compressor operating bounds. See, e.g., [0678] – [0685].

Knowing how to pulse fuel to increase pressure oscillation, and that controlling fuel and diluent changes reaction temperature, are insufficient to control the pressure to within one or more compressor safe operating bound. Instead, such control requires regulation relative to the

"safe operating bound" of the "co-reactant fluid delivery system" or air compressor as well as both the temperature and the pressure, as these may be controlled independently. Delivering diluent provides another degree of freedom in control above that taught by Stickler.

Faulkner is concerned over compressor pressure at "light-off" and over the assist air pressure. Neither Stickler nor Faulkner makes mention of "choke" or "surge" or how to maintain compressors within safe operating limits. Neither teaches or suggests controlling either fuel or diluent or the combination to control reactor pressure within safe boundaries to prevent compressor surge or reactor choke.

Applicant respectfully submits that Stickler with Faulkner and Meenan do not teach: "controlling the delivery of diluent fluid and reactant fluid to the reactor to control the pressure within the reactor to within at least one specified safe operating bound of the co-reactant fluid delivery system" per claim 78. Therefore, Applicant respectfully submits that claim 78 is further distinguished over Meenan, Faulkner and Stickler, taken singly or in any combination.

**Office Action page 9 (23)**

Claims 47, 48, 59 and 60 are rejected under 35 U.S.C. § 103(a) as obvious over Meenan in view of Faulkner and U.S. Patent No. 4,176,637 to Cole ("Cole"). Applicant respectfully traverses the rejection.

**Office Action page 9 (24) Claim 47**

As discussed above, Applicant respectfully submits that neither Meenan nor Faulkner individually or together teach the features of Claim 40. Meenan teaches uniformly spaced peripheral jets oriented radially into the combustion chamber. He apparently gives no instruction on orientations other than radially oriented jets, nor any explicit description of spacing other than apparent uniform peripheral spacing in perforated cylindrical tubes uniformly spaced along the combustor. Meenan shows perforated tubes peripheral to the flow, but he gives no instruction on differing penetrations of jets into the flow. Nor does Meenan show perforated tubes distributed across the flow.

Referring to Fig. 2, Cole teaches: "A discharge nozzle 42a is provided at the end of the fuel conduit for aiding in mechanically forming a spray of fine mist or small fuel droplets which are discharged outwardly into the chamber at high velocity." Referring to Fig. 3, Cole teaches: "The fuel is induced into the stream of flowing air or other oxidizing agent by venturi action and in accordance with the present invention, a generally frustro-conically shaped, electrostatic

charging electrode 56 in the form of a fine wire electrically conductive screen mesh is mounted downstream of the venturi nozzle 54." i.e., Cole teaches "mechanically forming a spray of fine mist or small fuel droplets", or "by venturi action". Furthermore, Cole does not refer to "distribution", nor "transverse", nor "spatial", nor "homogeneous", nor "inhomogeneous", nor "uniformity", nor "pressure", nor "composition". Cole only mentions velocity of fuel droplets.

Applicant respectfully submits that Cole does not anticipate control wherein: "the spatial distribution of each of the reactant fluid and the diluent fluid in the first transverse direction controls a spatial transverse distribution of one of the composition, temperature, pressure, and streamwise velocity of the product fluid, at a plurality of outlet locations along an outlet transverse direction through an outlet location near the reactor outlet, to one of:

greater than a plurality of prescribed lower limits, and less than a plurality of prescribed upper limits at the respective outlet locations." per claim 40 as currently amended.

Accordingly, Applicant respectfully submits that neither Meenan, Faulkner nor Cole teaches or suggests the methods to obtain the spatial distributions transverse to the flow of revised Claim 40 above, either singly or in combination. Claims 47 and 48 depend from claim 40 and incorporate its features by reference, and are submitted as patentably distinguished for at least the same reasons as their underlying independent base claim.

Claim 47 as currently amended recites "electrically exciting at least a portion of the reaction product within the reaction chamber."

By contrast to the recited claims, Cole teaches: ". . .electrostatically charging fuel particles to provide better dispersion and mixing with an oxidizing agent such as air for subsequent combustion . . .". Similarly "As the fuel air mixture passes through the electrostatically charged screen, the fuel particles are electrostatically charged by physical contact with the electrode and the charged particles repel one another and are attracted by the opposite charge on the hot intake manifold or conduit leading to the combustion chambers of the engine."

Cole's only reference to hot gases is in the downstream expansion: "a turbine wheel having blades 48 which are driven by the hot gases to rotate as indicated by the arrow 'A.' " It appears that Cole uses the electrostatically charged screen to "provide better dispersion and mixing". The "subsequent combustion" appears to be downstream of Cole's apparatus. Consequently Cole's is teaching exciting a cool fluid, not a hot product fluid per claim 47.

Accordingly, Applicant respectfully submits that neither Meenan or Cole anticipate the methods to "electrically exciting at least a portion of the hot fluid within the reactor" per claim 47.

**Office Action page 9 (24) Claim 48**

Claim 48 recites "modulating the reaction product to at least 2 kHz." As noted above, neither Meenan nor Faulkner satisfy the requirements of Claim 40. The Office Action observes that "Neither Meenan nor Faulkner discloses electrically exciting a portion of the hot fluid in the reactor to at least 2 kHz." As noted above, Cole teaches exciting cool fuel, not hot combustion products.

Furthermore, Cole explicitly teaches static not dynamic high voltage operation stating: "If the source is AC, it may be rectified by a diode 30 into suitable DC potential". "If the electrical source is AC current, a suitable rectifier circuit as described is provided to convert the AC to DC potential." Further, Cole makes no mention of "modulate", or "oscillate", or "vary" or "dynamic" or "frequency" or "Hz", or "pulsate", or "fluctuate", "acoustic", or "noise", or "pressure". Faulkner's only mention of "control" is to configure the compressor guide vanes to: "to control the flow of air through the compressor." Similarly, Faulkner does not mention "modulate" or "oscillate", "dynamic", or "frequency", or "Hz", or "pulsate", or "fluctuate", or "acoustic", or "noise", or "pressure".

Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach ". . . modulating the combustion products to at least 2 kHz" per claim 48.

**Office Action page 9 (24) Claims 59 & 60**

Claim 59 as currently amended recites:

"The method of claim 76 further including configuring a high voltage power supply for at least one of the reactant delivery system or the diluent delivery system and generating a high voltage electric field within the reaction chamber."

Claim 60 further recites "modulating the high voltage electric fields."

As described above, neither Meenan nor Faulkner nor together anticipate Claim 76. The methods taught to reduce flame temperature and NOx to not teach how to control:

> "wherein controlling one of the spatial distribution of the co-reactant fluid and of the diluent fluid, the distribution being taken along the first transverse direction through a reactor location along the primary flow in one of the diffuser and the reaction chamber; and

wherein controlling the transverse distribution of one of the composition, temperature, pressure, and velocity of the reaction product, to a prescribed spatial distribution, the transverse distribution being taken along the first transverse direction through a control location near the outlet of the reactor."

Cole teaches a centralized fuel nozzle 20a, 42a, or 54, with no indication of "controlling spatial distribution of fuel" "in at least one of the transverse directions", nor of "the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an outlet of the reactor . . ." Cole does not teach diluent delivery.

The proposed combination does not ameliorate their respective deficiencies. Therefore, the references, taken singly or in combination, do not teach or suggest all features recited in claims 59 and 60. Accordingly, applicant respectfully submits that neither Meenan, Faulkner nor Cole, singly or in any combination, make obvious independent claim 76, and consequently neither dependent claims 59 or 60.

Faulkner provides a diluent delivery system, but does not teach providing a high voltage power supply for it. Meenan provides neither a diluent delivery system nor a high voltage power supply for said diluent delivery system. Only Cole describes a high voltage power supply and that only for a fuel system. Cole provides no diluent delivery system.

Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach Claim 76 with dependent claim 59 "configuring a high voltage power supply for at least one of the reactant delivery system or the diluent delivery system and generating a high voltage electric field within the reaction chamber" per claim 59.

As noted above regarding Claim 48, Faulkner does not refer to modulating the electric field. As noted above regarding Claim 48, Cole teaches static DC high voltage, not dynamic voltage modulation. Applicant respectfully submits that Meenan in light of Faulkner and Cole do not teach "modulating the high voltage electric fields" per Claim 60.

In light of the foregoing, Applicant respectfully submits that the rejection over Meenan in view of Faulkner and Cole has been obviated, and kindly requests favorable reconsideration and withdrawal.

**Conclusion**

In light of the foregoing, Applicant respectfully submits that all claims are patentable, and kindly solicits an early and favorable Notice of Allowability.

Respectfully submitted,

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